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SCIENCE

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SCIENCE

Vol. 104, No. 2692 Friday, 2 August 1946

Plans and Problems in Nuclear Research

Farrington Daniels

Metallurgical Laboratory, University of Chicago

PERHAPS THE MOST IMPORTANT THING which has come out of scientific research during the war period is the pile, consisting of a structure of uranium and graphite or equivalent materials. Simple, silent, powerful, these potential giants are waiting for man to decide between abundant life and race suicide. Fantastic quantities of energy can be liberated by them in concentrated form, and they can produce enormous quantities of neutrons and radioactive materials for experimental purposes. In the rush of war research such piles were built in the simplest, surest manner with tight metal enclosures, cooled with air or water at comparatively low temperatures. Many new types of piles should now be designed and built, using all forms of fissionable material with different moderators and different coolants. All these must be investigated as to their ability to withstand high temperatures, erosion, corrosion, and neutron and gamma irradiation. Effective cooling and quick, absolutely reliable methods of control are necessary. A happy hunting ground is waiting here for the inventor and the gadgeteer. Although the Project scientists have considered many possibilities, I am sure that the release of Manhattan Project facts to fresh minds and to men of different experience will lead to important developments in piles. Because the minimum investment for any pile is so large and the physiological and political dangers so great, these piles must probably be government supported and government controlled.

Radioactive Isotopes

Radioactive isotopes are of two general types. The elements of the middle of the periodic table which are formed on fission are abundant on the Manhattan Project because for every gram of uranium or plutonium consumed in fission 0.999 gram of radioactive fission products is formed. The long-lived radioisotopes have been stored ready for separation. This separation from a grand mixture of all the middle-weight elements including all the rare earths is extremely difficult under any conditions, but all the more so because of the intense radioactivity which complicates chemical operations and keeps operators at a safe distance. New methods and techniques must be worked out for separation of these fission products. Some of these middle-weight radioisotopes will be useful as gamma-ray emitters and as tracers, and undoubtedly other uses will be found.

The more interesting and important radioisotopes, however, are those which are produced from light-weight elements by irradiation with neutrons in the pile, giving, for example, radioactive hydrogen, carbon, phosphorus, and iron. These radioisotopes are being produced now, but at the expense of the neutrons in the pile, and their production is limited. To increase this, more powerful piles must be built. Research on the best utilization of available neutrons is necessary in order to produce the maximum amount of these valuable isotopes for use in science and industry. Even if the world should be forced to consider prohibiting piles for power purposes until international morals can catch up with the progress of science, some piles should still be operated for the production of radioactive carbon.

Research is necessary also for the best utilization and recovery of these isotopes, and again more sensitive methods of measuring radioactivity will enable a wider use of the limited available store. Uses for these radioisotopes include radiography, tracers in industry, chemistry, biology, and therapeutics. A careful plan of distribution of these resources outside the Manhattan Project has been worked out and is now being administered (*Science*, 1946, **103**, 697).

Chemical Research

The production of new heavy isotopes and transuranium elements opens up an interesting new field which, combined with the study of the fission products,

Paper delivered at the meeting of the American Physical Society, held at the University of Chicago on 21 June 1946.

gives an extraordinary boost to the development of inorganic chemistry. With 96 elements, over 500 isotopes, and the addition of the time variable of radioactive decay, the new student of chemistry is confronted with an ever-increasing body of knowledge.

For the production of radioisotopes and for useful power throughout the world it will be necessary to obtain larger quantities of fissionable material. Uranium ores of low concentration are fairly widespread, and new methods of recovering uranium from these low-grade ores should be developed. Possibly uranium can be recovered as a by-product in some industries or in industries yet to be established. In the operation of the pile the materials become poisoned by neutron-absorbing fission products and weakened in physical properties because of radiation. When the situation becomes sufficiently bad, the material must be removed and treated chemically so that the atomic fuel of fissionable materials can be recovered, reprocessed, and returned to the pile. In order to handle these materials they must be decontaminated so that the radioactive fission products are reduced perhaps to the extent of one millionth of their original concentration. If this chemical processing has to be repeated at frequent intervals, it is necessary to have extraordinarily high efficiency—99.9 per cent recovery, for example; otherwise, there will be serious loss of the extremely valuable U-235 or other fissionable material used in the pile. Research is necessary to improve still further the chemical processing of the pile materials. It must be remembered that most of these chemical and metallurgical operations must be done by remote control, by pushing buttons and levers and peeking through periscopes at a great distance behind protecting shields. If a pump or a piece of equipment fails in the large-scale processing of pile materials, even this must be removed and replaced by machinery operated by remote controls.

Biology

One of the outstanding accomplishments of atomic energy research has been the protection of the health of the personnel. Accidents have been extraordinarily few as a result of vigilance, wise planning, and research. The budget for health and biology has been large, but it has been justified. Tolerance limits for safe handling of materials with alpha, beta, and gamma rays and neutrons had to be established. We came to the Project thinking in terms of millicuries and found that we had to face problems of curies and sometimes of centra- and even kilocuries.

Laboratories, equipment, personnel, clothing, all have to be checked constantly and monitored for radioactivity. Some operations have to be carried out with rubber gloves, often inside awkward dust-proof boxes. Of course, the most difficult problem was to make the eager scientists obey the rules designed for their own good. So much effort has been spent on prevention that very little time has been devoted to possible cures for overexposures or accidental intake of radioactive materials. Research along these lines should now be emphasized.

Disposal of radioactive materials constitutes a very serious difficulty, and new methods, such as precipitation, adsorption, electrostatic-precipitation drying, and incineration, are desired. One of the greatest needs is for a more efficient shield for gamma rays. Lead and concrete are satisfactory, but someone may think of a new principle, possibly using resonance or photochemical reaction or something else, to stop gamma rays which does not depend on just sheer mass.

Research into the mechanism of radiation damage is important and a great deal of work has been devoted to it. Alpha, beta, and gamma rays and neutrons all seem to act through ionization within the body tissue. If one measures the total ionization effect, he will have a fair indication of the body effect no matter which of these different agencies is responsible for the actual ionization. Alpha and beta rays are easily stopped by thin shields, while gamma rays require very thick shielding (more than five feet of concrete for an effective pile), and neutrons require shielding of a special type containing neutron absorbers such as hydrogen, cadmium, or boron.

Even though adequate shielding is provided, one must worry about the intake of materials which will emit these alpha, beta, and gamma rays within the body. Radioactive material may be taken into the stomach, through certain radioactive solutions accidentally dropped on the hands of a laboratory worker and evaporated, or from dust in the laboratory settling on clothes or hands and later transferred to food. Radioactive materials of certain half-lives taken into the stomach tend to be discharged slowly, at rates which have been thoroughly studied. Intake into the blood stream is still more serious, and any scratches or abrasions of the skin must be regarded as a serious condition by all who work with radioactive substances. Such materials can also enter into the lungs in the form of dust. Rubber gloves, change of clothing, special facilities for eating—all these precautions and many more are necessary for those who work with special radioactive materials.

These difficulties pose serious problems of waste disposal. Fortunately, the detection of radioactivity by instruments is extremely sensitive, so that any condition detrimental to living material can be detected first with physical instruments. Radioactive materials cannot be dumped down the sink without

eventual pollution of the sewage. Oxidation and chlorination are of no help in radioactivity purification. One cannot allow radioactive materials to get into the air—they must be sent up through hoods, and filters or precipitators may be necessary to prevent the material from contaminating the neighborhood. Disposal of experimental biological material is also a serious problem. For example, the body of a rat which has been injected with radioactive materials cannot be placed in an ordinary collection can or buried upon completion of the experiments. A prowling animal may eat the radioactive carcass. Long after the carcass is disintegrated long-lived radioelements will persist in the ground. Special storage or controlled incineration is needed.

Little has been done on clinical uses of radioactive materials, but research is progressing. Radioactive carbon, iodine, phosphorus, and iron will soon be invaluable for these purposes. Possibly radioactive compounds will be found which will be absorbed preferentially on rapidly growing cells in such a way as to inhibit abnormal growths. The organic chemist is being called on to synthesize from radioactive elements compounds which can be directed to various parts of the body for therapeutic purposes.

New Tools

Successful developments in science follow closely the development of better instruments. We have developed electrometers and Geiger-Müller counters for alpha, beta, and gamma rays and neutrons which are superior to, and more sensitive than, those heretofore available. These are used for laboratory researches, control of piles, health monitoring, and ore exploration. Multiple alpha-ray counters give complete simultaneous information concerning ranges and intensities of a mixture of alpha emitters and have helped to discover new radioactive decay series in the heavy elements. The health instruments are designed to snoop along surfaces of desks and floors for alpha and beta activity to detect gamma radiation and air-borne radioactive dust and to ring an alarm when a person with radioactivity on his clothes passes through a door.

Among the new tools piles stand pre-eminent. By measuring a slight change in activity of the pile one can determine the neutron absorption of a very small piece of material with extraordinary accuracy due to the chainreacting multiplication of neutrons. The high neutron flux makes possible the production of large quantities of radioisotopes and the carrying out of significant experiments with neutron beams, including scattering and absorption measurements with crystal spectrometers. New physical and chemical properties have been made available for study by exposure to intense neutron radiation.

Atomic Power

One of the most intriguing problems raised by the atomic energy program is the production of useful power to give electricity from piles. Power piles are technically feasible, and now that the war strain has been released, attention is being devoted to the building of pilot plants. Little can be said yet regarding the economic possibilities of power. If we take a short-range view with the expensive enriched materials now available, we know that we can produce useful power throughout the world, but we know also that at least in this country it will be much cheaper to use coal or other combustible fuel in standard machines. On the other hand, if we take a long-range view, it seems likely that power piles will be important, and they will do much to supplement the available sources of combustible fuel, heretofore considered our only sources of useful fuel. We should consider not only our own country but also other regions of the world where there is impelling need for the development of more electrical power. Because power piles must be operated at high temperatures to give high thermodynamic efficiency, the properties of suitable moderators and coolants must be studied over a wide range of conditions. A great deal of time-consuming research remains to be done.

Neutrons are lost by internal absorption as well as by external escape. They may be absorbed by the moderator, by impurities in the moderator and in the uranium, and by structural materials of the pile. One of the most important bottlenecks in building the first pile was the production of metallic uranium and graphite of sufficient purity. Some of the common structural metals which one would like to use inside the pile cannot be used because they absorb too many neutrons.

One of the most challenging problems in pile design is removal of the enormous quantities of heat. Particularly in small piles, using plutonium or pure or enriched U-235, heat-transfer problems of a new order of magnitude will be involved. Water, gases, gases under pressure, and liquid metals are among the possible coolants. The coolants, of course, must have a low absorption for neutrons, must be chemically and physically stable when subjected to intense radiations, and must not corrode or erode the material of the pile with which they come in contact.

The burning of a fuel such as coal or gas in air gives a temperature which is limited to perhaps 2,000° C. No such limits exist for the heat generated in the pile. But again there is no way of utilizing heat at higher temperatures because at present no alloy or

metal is available which will withstand the oxidizing conditions of the ordinary combustion fuel at temperatures above 1,000° or 1,100° C. In the pile, however, an oxidizing atmosphere is not needed—helium or metal can be circulated through the pile, the oxidation being avoided. Theoretically then, it would be possible to use tungsten or molybdenum at temperatures up to 2,000° C. At present we are limited to about 1,000° or perhaps 0.1 electron volt. Possibly we may some day climb up to around 0.2 volt and obtain a much higher thermodynamic efficiency than we have at present. Theoretically, perhaps these atomic fuels could give us energies of millions of volts instead of the 0.1 or 0.2 volt, but no means of utilizing this high-intensity energy directly has yet been developed.

Let us turn now to some of the *problems* involved in nuclear research.

Secrecy

The compartmentalization of scientific workers on the Manhattan Project, which prevented free exchange of scientific reports and information from one laboratory to another, has been annoying, and it has constituted a handicap in the research program. During the war we all accepted it as a necessary evil. Now that the war is over, the scientists object strenuously to its continuation. But many are convinced that secrecy and restrictions of publication will still be necessary in some branches of atomic energy research. Prior to the atomic bomb, only philosophers and economists had to consider their responsibility to the public in their speeches and pronouncements, while scientists were perfectly free to talk about anything they chose because anything they might say would have little influence on the social and political aspects of their society. Now, however, public release by a physicist of the number of neutrons produced in fission of plutonium or the description by a chemist of a means of effectively separating plutonium from its fission products on an industrial scale immediately carries international complications.

I am afraid that some of the bars of secrecy will have to remain. The scientists at the Metallurgical Laboratory know nothing about the construction of the atomic bomb, and we have in our library nothing about the weapon. Moreover, none of the scientists wants to have any such material available, and I am sure that they welcome this restriction.

Publication

The publication of research offers serious difficulties. The situation is somewhat unique—hundreds of scientists have worked feverishly for four years without any chance to publish their material in the standard journals or in books. The material is recorded in the form of thousands and thousands of reports, many of which have been progress reports and hastily prepared reports designed to meet emergencies.

Many of these should never be published. Most of them should be coordinated and rewritten in the light of subsequent findings in the laboratory. For the past year this Laboratory has devoted a considerable part of its time to writing up in final form this vast accumulation of scientific material. Other laboratories within the Manhattan District have been writing similar records, and when all these reports can be published you will be surprised to learn how much has been accomplished in science even though the advancement of science was not our chief aim. As an illustration, I think that we know more about the chemistry of the new, artificially-produced element, plutonium, than we know about the chemistry of half of the pre-war elements. The Government has undertaken to have all the scientific material published either for public or private circulation.

The declassification of the secret documents of the atomic energy project has been a difficult problem. A civilian committee headed by R. C. Tolman was established by the Manhattan District of the U. S. Army to formulate rules by which the research material can be made available to the scientists and the general public. This declassification code is now in operation, specific documents being declassified on the recommendation of the Laboratory Director, a responsible referee, and the patent advisers. The Army administers this procedure, but the rules are established and interpreted by the civilian scientists. A large fraction of the material is now declassifiable and provision has been made for revision of the rules from time to time.

A troublesome problem now being faced is the publication of this material in the standard journals since, once it has been published in book form, the scientific journals will probably not wish to accept it. Conversely, it may be difficult to find a book publisher if much of the material has appeared previously in scientific journals. Another problem involves the release by individuals of this work which has been done at government expense. It might be easiest to adopt a laissez-faire policy and attempt no control, but then the more aggressive men would get their material out first and in so doing might rob the less aggressive men of the proper credit. The situation differs from that which prevails under ordinary conditions in scientific laboratories because free publication in the usual manner has been denied for the past five years.

Another problem is that of review articles. Ordinarily it is proper and desirable for an expert to comb the public literature and write review articles

which will present the material of any individual paper in a critically evaluated and convenient form for the average reader. But if these review articles are made up from project reports which have not yet been published the reviewer will in a sense skim off the cream for publication, and even though the scientific worker is given full credit for the experimental work, he would probably prefer to present his own work first in the standard scientific journals. On the other hand, the men of the Manhattan District feel that they are carrying a heavy responsibility as custodians of the vast amount of scientific knowledge which properly belongs to the Nation and to the world.

These problems are acute, and they have been given very conscientious, thorough attention by both scientists and Army officials. Whereas many have blamed the Army for the secrecy restrictions and the publication difficulties, the unique situation rather than the Army itself is to be blamed. The Army acts as a buffer between the scientists and the public. A long time will be required to educate the public with regard to our point of view, namely, that (1) there are no secrets in the fundamental facts of science; (2) even if there were secrets of science, we could not hope to keep them from others except for a very brief time; (3) we should not handicap our own scientists and the normal development of scientific research in our own country by withholding the knowledge which we have accumulated during the war; and (4) by attempting to withhold the so-called secrets we would incur ill will throughout the world.

Let me emphasize, however, that we have taken positive forward steps in publishing the Smyth Report and the State Department Report on International Control.

Much of the disagreement concerning secrets of atomic energy is caused by a confusion in definitions. Information concerning weapons, production rates, and plans constitutes military secrets which should not be made public, whereas constants of nature and ordinary fundamental work in science cannot be kept secret. Engineering information and technological techniques constitute an uncertain borderline field similar to that in which industrial companies sometimes try to keep trade secrets.

Shortage of Scientists

A most serious problem facing the development of atomic energy is the shortage of men trained in the sciences. This situation is, however, not unique in the field of atomic energy: there are too few scientifically trained men for the whole country—in industry, in research, and in teaching. Unfortunately, the training of young scientists in the colleges of the United States practically ceased for the period of the war. Other countries were not as shortsighted. The demand now is so great that competition for men is acute, and the government laboratories find it difficult to keep their men. Industry probably pays higher salaries, while universities offer greater freedom of research, more attractive surroundings, and greater security. Reasonably high salaries and freedom of research will be necessary in order to keep even a skeleton crew of atomic scientists at work on the development of this important field.

During the war times scientists would accept any working conditions and any arbitrary rulings which were necessary to help win the war. The same spirit of subordination of personal desires cannot be expected now that the war is over. One of the most cherished prerogatives of the scientist is to carry his research wherever his ideas may lead him. Under Army direction there was extraordinary cooperation between the academic scientists and the industrial engineers even though these two groups have rather radically different philosophies. In industrial developments the ideas come largely from the top, and orders are given to those who are helping with the project. In academic research the ideas come largely from the bottom. Each investigator is more or less of an individualist whose ideas and accomplishments are transferred into action through supervisors and administrators. Under peacetime conditions it is more difficult to continue this type of wholehearted cooperation between groups with such different viewpoints. The scientists in one laboratory may be asked to work primarily on weapons, but they do not want to work on weapons—they insist on working on fundamental academic research for at least part of their time. Scientists in other laboratories are told that they must concern themselves primarily with industrial applications and production, but many of the creative scientists, who are needed to make such a project a success, strenuously object to restrictions and insist properly that they have a right to work on fundamental research as well. Still another laboratory is supposed to be constituted primarily of academic scientists in a university atmosphere who are to devote themselves to fundamental research. Some of these, however, may develop practical ideas for the construction of some unit which calls for an engineering development. They want to go along with this development and see their ideas carried through to successful conclusion. If such scientists are denied the chance to carry through to a pilot-plant stage, they will become dissatisfied. It will be necessary for successful development in the field of atomic energy to allow the academic scientists considerable freedom to choose their own research problems. However, there are

important jobs which the Government must get done, and the scientists of the government laboratories have an obligation to see that they are done.

Research Policies

The determination of nuclear constants; the design of piles; the development of new chemical processes; the discovery of new elements and their chemical and physical properties; the invention of new instruments; the production of uranium, graphite, and other materials on a large scale at previously unheard-of purities; the design and construction of enormous operating plants in record time—all these and many more stand out as almost miraculous accomplishments. But they were not obtained without the sacrifice of thousands of scientists drawn from other important activities, draft deferments, top priorities, much of the country's stainless steel, and 1 per cent of the Nation's wealth. Although some praise the great accomplishments of scientific research in wartime and imply that they are due to the war effort, we do not subscribe to the view that war accelerates science. We know that these dramatic results merely represent a cashing-in on years of fundamental research which went before. Meantime, the reserve of fundamental science is not being replenished at its normal rate, as is evident from the dwindling size of our scientific journals through the war period. I must emphasize, however, that the Manhattan Project has contributed its share to the development of pure science. Thousands of pages of finished manuscript on plutonium, uranium, radioactive substances, and biological effects of radioactivity are now awaiting release for publication, and a large part of the record in chemistry, metallurgy, and physics is ready.

The importance of fundamental research should again be emphasized. Although near-miracles were accomplished by mass production and organized research in an uncharted field, better results can be obtained in a normal, long-range program by a more fundamental approach in which experiments are planned not for immediate answers to specific programs but for the mastering of general principles. In this way we can more intelligently design our machines and processes, and when we find that we need to make changes in the light of further testing, we can alter our plans without having to wait for a whole new set of empirical laboratory experiments.

Regional Laboratory

The Army has very wisely decided to continue the research laboratories which were so successful during the war and in general is trying to set up organizations which can be taken over easily by the new Atomic Commission when it is established. It is planning to make the laboratories available for the use of the universities. An effective cooperating organization has already been set up in connection with the atomic energy laboratory at Chicago. Twenty-five universities of the Middle West are cooperating in the administration of this laboratory, operated for the present under contract by the University of Chicago. Pioneering work is being done in the organization of this regional laboratory, and the articles of organization will soon be available to those interested.

It is proposed that atomic energy research of value to the Government be carried on by a permanent staff. This permanent staff also will have opportunity to engage in a research program of its own choosing. Temporary staff members will be welcome from anywhere in the country and in particular from the staffs of the cooperating universities. If the research program is of primary interest to the cooperating university, the salary of the investigator who comes to this Argonne National Laboratory will be paid by the cooperating university, and the research will be published from the cooperating university with a by-line to the Laboratory. If the work is of primary concern to the Government or if the visiting scientist prefers to work on a problem sponsored by the Argonne National Laboratory staff, the salary of the visiting scientist will be paid by the Government, and the publication will be from the Laboratory and the cooperating university.

Among the many problems which are now being solved are the fixing of legal responsibility for accident compensation, the loan of special instruments and arrangement for transportation of radioactive materials, for financial reimbursements, if any, and for the use of special utilities and materials. New laboratories must learn safety methods and will want the loan of our health experts. We look for a vigorous, interesting development not only in the encouragement of scientific research but in the cooperation of many separate universities and in the training of atomic scientists.

Conclusion

These problems which I have attempted to enumerate seem important, but they are insignificant in comparison with the one fundamental problem of international control and the organization of the world to prevent war. If the human race is to survive, we cannot continue. As scientists we are keenly aware of the benefits of international cooperation. We want world-wide freedom for the human mind. As discoverers of new nuclear forces we feel our responsibility for their use in the world. As citizens we must use our influence vigorously toward effective world government as the means for permanent peace

Science Legislation

Obituary: National Science Foundation, 1946

Howard A. Meyerhoff

At noon, 19 July 1946, The National Science Foundation was pronounced dead by the surgical staff of the House Committee on Interstate and Foreign Commerce. The death was a homicide!

Readers of *Science* are familiar with the promising career of the deceased, and many will mourn this untimely and unnatural passing, for the killing was done, not by politicians, but by scientists. Friends of S. 1850 may find a little—but very little—consolation in the fact that HR 6448, the cause of S. 1850's death, died at the same time.

The events preceding the tragedy may be briefly recounted: Following passage of S. 1850 in the Senate on 3 July by a vote of 48 to 18, the bill was referred to the Subcommittee on Public Health in the Committee on Interstate and Foreign Commerce. The bill came to this subcommittee solely because the sponsor of HR 6448 had arranged to have his bill referred to the Committee on Interstate and Foreign Commerce, where, presumably, it would be in "friendly" hands. This subcommittee was the only one within the larger committee that had experience with anything akin to science, and so it was charged with the responsibility of studying and reporting on the competing National Science Foundation bills.

In the face of this responsibility, J. Percy Priest, chairman of the Subcommittee on Public Health, decamped to direct affairs connected with his forthcoming campaign for re-election in his home district in Tennessee. The National Science Foundation bills were left with his fellow committeeman, Alfred Bulwinkle of North Carolina. On 16 July, under Representative Bulwinkle's guidance, the Subcommittee reported out a slightly modifed version of HR 6448.

The subcommittee report went to the Committee on Interstate and Foreign Commerce Friday, 19 July. Under the questioning of the full committee, the subcommittee could not make a case for HR 6448, nor had it the background to defend the rejection of the Senate Bill. Lacking the bases for intelligent decision the Committee on Interstate and Foreign Commerce took the only course of action available to it: The bills were tabled "because the legislation was too complicated and important" for action with the information at hand.

Offhand, Alfred Bulwinkle, Percy Priest, and the other members of the Subcommittee on Public Health might be judged culpable, but it would be unfair to place the onus of the Foundation's death upon them. It must be placed upon the shoulders of those who drafted and introduced the Mills Bill, HR 6448, into the House. Let no one be so naive as to suppose that this was Representative Mills. The record establishes the responsibility. In the report of the hearings of 28 and 29 May, 1946, on HR 6448 the following excerpts are illuminating:

On page 16, Representative Mills states: "The recommendations contained in the Bush report *Science, the Endless Frontier* became the basis for a bill (HR 3852) which I introduced in the House on July 19, 1945. A companion bill (S. 1285) was introduced by Senator Magnuson. . . . After carefully studying the provisions of S. 1850 I came to the conclusion that H.R. 3852 . . . was a better bill for most of the problems involved than S. 1850, although there were a few points mentioned in the Senate hearings that had not been covered in HR 3852. Therefore, I revised my original bill to include some of these points." And further, on page 17, "it is appropriate for the Congress to review the situation at this time to determine whether it is in the public interest to establish an organization designed to operate in the same manner and in a comparable field as OSRD."

On page 55 Homer W. Smith states: "As you know, the Magnuson Bill (S. 1285) was drawn up in close consultation with Dr. Bush."

On page 50, Vannevar Bush observes: "I think this piece of legislation you have before you, HR 6448, is an excellently drawn piece of legislation, that it has been very carefully prepared . . . ," and he proceeds to demonstrate that it incorporates all of his own personal convictions on the organization of a National Science Foundation.

At least two of the witnesses who appeared at the hearings on HR 6448 were persuaded to testify on the strength of an assertion that S. 1850 would not be passed by the Senate, and that the introduction of a new bill in the House was the only hope of salvaging the National Science Foundation in the 79th Congress.

It is possible that Dr. Bush was similarly misled, but the fact remains that he must personally assume the burden of responsibility for the introduction of a bill for which his own representative arranged the hearings on 28 May. Congressman Mills had as much to do with the revision of HR 3852 into HR 6448 as he had to do with the drafting of S. 1285–HR 3852, which, as the testimony shows, was next to nothing.

Many scientists had voiced their objection to having a peace-time Foundation created in the image of the Office of Scientific Research and Development. But regardless of the motives which prompted the introduction of HR 6448 it was unilateral action betraying the democratic principles upon which the compromises in S. 1850 were worked out in conference. Furthermore, HR 6448 violated practical political procedure in proposing a nine-man, part-time board of scientists to administer the affairs and the millions of the National Science Foundation. Many Congressmen have voiced serious objections to this type of administration, and in his testimony (p. 27) Secretary of War Patterson says "I believe in agencies with a single administrator to take the full responsibility for the performance of the Government agency . . . rather than division of responsibility among the members of a board." In view of the fact that "a White House spokesman" had predicted a presidential veto for science legislation creating this type of administration, insistence on a part-time board was something less than astute.

In content, in timing, in complete misjudgment of the strength of S. 1850, HR 6448 was a political blunder which has cost science at least a year of life for the National Science Foundation. Every scientist has the right to his convictions, but no scientist—no group of scientists, whether a majority or minority—has the right to impose its convictions at this cost. The moral of 19 July is simple: *Only in a reasonable show of unity, achieved by some compromise, can scientists expect political results.*

Association Affairs

Scientific Exhibits

113th Meeting, Boston, 26-31 December 1946

The Committee on Exhibits for the Boston Meeting has announced the availability of space for scientific exhibits together with application procedures. The scientific exhibits will be housed with the technical exhibits in the First Corps Cadet Armory, which is located opposite the AAAS headquarters, Hotel Statler.

It is the purpose of the Committee to arrange a wide variety of selected exhibits which will (1) portray scientific advances in the various fields of science; (2) show new techniques and apparatus usable in the laboratory or in classroom teaching; (3) summarize research in a given field. The Committee feels that personal demonstration is the most important single factor for a successful scientific exhibit. Both the visiting scientists and the demonstrator benefit from such a presentation. Originality in planning the exhibit is encouraged; charts, drawings, transparencies, specimens, and other materials can be shown in a variety of ways, using light and color judiciously. A large expenditure of money is not necessary.

In general, the space allocated will be 6 feet deep and 10 feet wide. A 10-inch shelf at table height runs around the three closed sides of the booth. The backdrop is of plywood and can be used for hanging or tacking materials. The Committee in its discretion may allocate a greater width than 10 feet. Booths, including illumination, necessary electrical outlets, two chairs, uniform name signs, and general service, are furnished to exhibitors without charge. The exhibitors pay the expense of the preparation, transportation, and installation of their exhibits. Special construction in the booth, extra tables, chairs, or other furniture can be obtained at regular rates from the decorating firm. Application forms for scientific exhibit space may be obtained from: Theo. J. Christensen, Director of the Science Exhibition, AAAS, Massachusetts and Nebraska Avenues, N.W., Washington 16, D. C.

Those who are interested in exhibiting should request forms immediately. The closing date for applications will be 15 September 1946. Applications will be acted on by the Committee as soon as possible after that date and notification sent to exhibitors.

Technical Papers

On Reporting the Comparative Values and the Biological Activities of Chemotherapeutic Agents

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The existence of many chemotherapeutic agents, among which the sulfonamides and antibiotics are at present the most prominent, presents the problem of determining the comparative therapeutic values of these compounds.

It is customary to compare bacteriological and pharmacological activity, especially among the sulfonamides and the antibiotics, on the basis of the milligram or milligram per cent concentration appearing in the blood or other fluids.

Often, however, there are considerable differences in the molecular weights of substances tested for therapeutic activity (*5*). It should be obvious that in making comparisons of biological activity the use of the milligram standard favors those compounds with the lower molecular weights.

Litchfield, *et al.* (*4*) stated that discrepancies in the comparisons made by different workers of the effectiveness of different drugs point to the need for a reliable quantitative method for assessing the activity of such compounds. They suggested that, since the concentration of a drug in the blood and tissues is the determining factor in therapy, a quantitative evaluation of effectiveness should be based on blood concentration. They added, however, that comparative values in reference to a suitable standard offer the most reliable measure of effectiveness.

It is proposed that these refinements be carried one step further. Although most pharmacologists are aware of the importance of considering molecular weights and molar concentrations in comparing the activities of compounds, only a few record these aspects in the literature. Moreover, often where comments are made concerning molar concentrations, they are not sufficiently extensive. The several references which are cited to show the absence of molecular standards for comparison have been chosen more or less at random from the current literature, are assumed to be representative of current practice, and are not to be construed as either direct or implied adverse criticism of the authors.

That misinterpretations, although frequently not serious, do result from nonmolar evaluation becomes evident from a study of the following comparisons:

(1) White, *et al.* (*9*) studied the qualitative antibacterial activity, both *in vitro* and *in vivo*, of 126 compounds against the B-hemolytic streptococcus in mice. "The final concentration of drug in each case was 10 ± 1 mg. per cent. *In vivo* tests were carried out by the drug-diet procedure." From their tables, compounds Nos. 20, 49, 82, and 106 have the same relative qualitative *in vitro* activity (++), although Nos. 20 and 106 are in saturated solutions having a concentration of less than 10 mg. per cent. The *in vivo* activity is also essentially the same for these four compounds. When these derivatives are compared on a molar standard, the activity ratio becomes as follows: No. 49—1, No. 106—3.2, No. 82—4.0, and No. 20—4.4.

(2) Latven and Molitor (*3*) have investigated the intravenous toxicity of eight organic solvents. From their data, given in cubic centimeters, the LD_{50}'s in grams and in moles have been calculated and are as follows:

	LD_{50} in grams	Order of increasing toxicity	LD_{50} in moles	Order of increasing toxicity
Al (70%)	3.56	6	0.077	4
Al (90%)	4.44	4	0.097	2
C	4.41	5	0.033	7
D	2.71	8	0.015	8
Eg	3.35	7	0.054	5
El	0.62	9	0.005	9
Gl.	7.55	2	0.082	3
Pg	8.30	1	0.109	1
Trig.	7.23	3	0.048	6

While the difference in the order of toxicity is not striking, there are differences in five of the eight compounds. It is not too unlikely that, had longer chain compounds of the same series been included, the discrepancies would have been greater.

(3) In the determination of therapeutic ratios, the toxicities of the compounds investigated are important. Walker and Van Dyke (*8*) have shown that, molecularly, sulfanilamide has an acute toxicity (LD_{50}) of about 13.6 millimoles (or 2.314 grams/kilo body weight when injected as a single subcutaneous dose in Swiss mice. From data in a report by Robinson and Molitor (*7*) the approximate acute LD_{50} of gramicidin injected intravenously into white mice is 3.0 mg./kg. (or 0.002 millimole/kg.). For the sake of the example, let us assume that, intravenously, the LD_{50} of sulfanilamide for the Swiss mice would have been only one-half that of the subcutaneous dose. Compared to sulfanilamide, therefore, gramicidin is 386 times as toxic, milligram for milligram. Mole for mole, however, gramicidin is 2,900 times as toxic.

Since it is likely that there will eventually be syn-

thesized compounds in which both sulfonamides and antibiotics are incorporated in the same molecule, it is entirely conceivable that comparisons will be made between fairly low molecular weight substances and those, like proteins, having weights perhaps 100 or more times as great. While it may be expedient to use milligrams as a standard of reference, chemically this is unsound.

Since one of the primary goals of pharmacology and chemotherapy is the discovery of the relationship of chemical structure to pharmacological action, a chemical terminology will expedite chemical reasoning. It is an arduous task to survey the literature and to convert milligrams to molar concentrations in studying the physicochemical relationship of structure to biological activity. The addition, in papers, of one column of molar concentrations complementing the milligram data would be not only considerably time-saving to other investigators but enlightening as well.

It is suggested, therefore, that when comparative values and the biological activities of chemotherapeutic substances are reported, a molar or micromolar concentration (cf. the excellent tables of Hjort, *et al.*, *2, 6*; and DeGraff, *et al., 1*) be used as a standard.

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4-Thio- and 2,4-Dithiobarbituric Acid Derivatives

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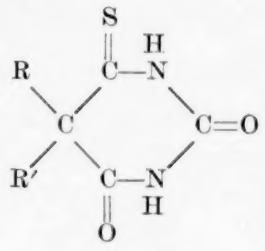
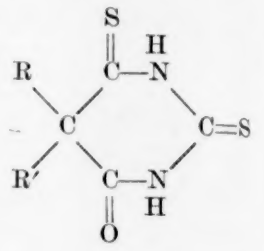
Until recently no substituted barbituric acids were known in which more than one of the oxygen atoms were replaced by sulfur, although the preparation of 2,4,6-trithiobarbituric acid by the action of potassium hydrosulfide on 2,4,6-trichloropyrimidine had been described (*2*). Henze and Smith (*5*) reported the preparation of 5,5-diethyl-2,4,6-trithiobarbiturate and 5-ethyl-5-phenyl-2,4,6-trithiobarbiturate, stating that these possessed no hypnotic properties. In 1944 Carrington (*3*) prepared the 2-thio, 2,4-dithio and 2,4,6-trithio derivatives of a series of barbiturates, using those barbiturates that are well-known hypnotics. No pharmacology was reported.

Using hydrogen sulfide under pressure, we have prepared several 4-thiobarbiturates (I) and 2,4-dithiobarbiturates (II) from the corresponding imino compound.



(I)



(II)

The imino group in other organic compounds has been replaced by sulfur. Carbon disulfide was used by Hofmann (*7*) and Hobrecker (*6*) to prepare diphenylthiourea from diphenylguanidine. Thioamides were prepared by Bernthsen (*1*), using amidines and hydrogen sulfide. Imido esters were converted to esters of thioncarborylic acid by Matsui (*8*) in 1908. Many iminobarbituric acid derivatives (*4*) are known, and it was thought that the imino group in these might respond in a like manner.

A few grams of a dialkyl-4-iminobarbituric acid or a dialkyl-4-imino-2-thiobarbituric acid were mixed with several hundred cubic centimeters of absolute ethyl alcohol that had been saturated previously with hydrogen sulfide at 10 pounds pressure. This was quickly placed in a bomb and heated at 150° C. for 12 hours. The product was isolated by evaporation of the alcohol, dissolving the residue in 5 per cent sodium hydroxide, filtering, making slightly acid with hydrochloric acid, and precipitating the thiobarbiturate.

In the 5,5-dialkyl-4-thiobarbituric acid series, only two compounds have been tested pharmacologically: 5,5-diethyl-4-thiobarbituric acid and 5-ethyl-5-isopropyl-4-thiobarbituric acid. After intraperitoneal administration, both of these compounds showed a marked depressant action, causing anesthesia with a rapid onset and short duration when administered to rats or rabbits. This depressant action was accompanied, however, by a stimulating or convulsant action which caused the muscles of the test animals to twitch slightly during the early stage of anesthesia.

In the 5,5-dialkyl-2,4-dithiobarbituric acid series four compounds have been tested pharmacologically by intraperitoneal administration to rats. The 5,5-diethyl-2,4-dithiobarbituric acid, 5-ethyl-5-n-butyl-2,4-dithiobarbituric acid, and 5-ethyl-5-isopropyl-2,4-di-

thiobarbituric acid showed much the same picture as the dialkyl-4-thiobarbituric acids except that the twitching action lasted for a longer period of time.

The 5-ethyl-5-isoamyl-2,4-dithiobarbituric acid, administered to 15 rats, showed the most promising indications. Two of the rats showed signs of very mild twitching. Upon intravenous injection of 20–30 mg./kg., rabbits lost the righting reflex instantly and in about 12 minutes. The placing reactions were recovered in 15 to 20 minutes. No subsequent ill effects or convulsant actions were observed. Death was caused by injection of 80 mg./kg. A few experiments on cats showed the same effect as those on rabbits.

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Influence of Streptomycin on Type b *Haemophilus influenzae* [1]

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Waksman and associates (*3, 5–7*) and others (*2, 4*) have reported the efficient antibacterial action of streptomycin toward a number of Gram-negative bacilli. These results suggested that this antibiotic might be active against Type b *H. influenzae*. Although specific rabbit serum and sulfadiazine have been highly successful in the treatment of influenzal meningitis in infants and children (*1*), it was thought that streptomycin, if effective, would offer advantages over this therapy; further, when used in conjunction with serum and chemotherapy it might reduce the present fatality rate.

An attempt was made to devise a simple, reliable procedure which, by determining *in vitro* the sensitivity of a given strain of *H. influenzae* to streptomycin,[2] might predict the influence of this antibiotic on infections caused by it in humans.

The sensitivity of a number of strains of Type b *H. influenzae* was determined under conditions which revealed the influence of size of inoculum, physical state of medium (Levinthal broth or agar), and duration of incubation period during exposure to streptomycin. The results indicate that the sensitivity of a given strain can be assayed reliably by inoculating a series of Levinthal agar plates containing varying concentrations of streptomycin with a 2-mm. loop of a culture grown for six hours on Levinthal agar or broth. The lowest concentration of the drug which prevents visible growth after 48 hours of incubation is designated as the minimal effective concentration (MEC).

Twenty-two cultures, isolated prior to treatment from patients with severe Type b *H. influenzae* infections, were examined for MEC. When the Levinthal broth culture, grown for six hours, was used as the inoculum, all strains were sensitive to concentrations of approximately 3 units or less/cc. When the loop of culture used for seeding the test plate was obtained from the growth on Levinthal agar after six hours of incubation, the MEC of seven of the strains was 7.5–10 units/cc. These results suggest that Type b *H. influenzae* is among those organisms which are highly sensitive to streptomycin.

Early in the study there was isolated from a meningitis patient who had been under treatment with streptomycin for two weeks a strain of Type b *H. influenzae* capable of growth on Levinthal agar containing 525 units of the antibiotic/cc. The same organism cultivated from the spinal fluid before treatment showed a MEC of 2.5 units/cc. Demonstration of a decrease in the MEC of resistant strains following subculture in the absence of streptomycin emphasizes the need for immediate preservation of the organism by drying and sealing under vacuum if its sensitivity to streptomycin at the time of isolation from the patient is to be appraised reliably at a later date.

This experience led to examination of development of resistance *in vitro*. The progress of adaptation of 16 sensitive strains was studied by subculturing at from 24- to 48-hour intervals the growth on the Levinthal agar plate containing the highest concentration of streptomycin to another series of plates of the same medium with the same and increasing concentrations of the antibiotic. Within one to three weeks seven strains had acquired the ability to grow in the presence of 525 units/cc. Six required four weeks to reach this degree of resistance. Three strains failed to grow in concentrations above 157 units/cc. after an adaptation period of four weeks.

These experiments provided a group of resistant strains which, together with the culture made resistant during treatment of a patient, could be used for study of correlation between MEC *in vitro* and the minimal dose required for protection in mice. Mouse protection tests determined for eight different strains the minimum effective dose (MED), *i.e.* the smallest single intraperitoneal dose of streptomycin which

[1] The work reported in this communication was supported by grants from the Commonwealth Fund.

[2] The streptomycin was supplied by E. R. Squibb & Sons. The dried powder contained approximately 300(2) units/mg.

would protect 50 per cent of the mice against 20,000,000 organisms. This infecting dose represents 100,000–1,000,000 LD_{50}.

Table 1 records the MEC and MED for the eight cultures, four of which were sensitive and four resistant according to *in vitro* tests. Strains 1, 2, 3, and 4 were isolated from patients before treatment with streptomycin and had never been exposed to this drug *in vitro*. These same strains, after acquiring varying degrees of resistance to streptomycin according to *in vitro* assay (1a in a patient and 2a, 3a, and 4a *in vitro*), required correspondingly higher MED in mice. In fact, we have not been able to demonstrate that it is possible to protect mice against strains capable of *in vitro* growth at 525 units/cc. and above. Strain 1b, produced by cultivating 1a in Levinthal broth in the absence of streptomycin, is shown to be sensitive *in vivo* and *in vitro*. It seems clear that high correlation exists between the MEC *in vitro* and the MED necessary to protect mice against 15,000,000–20,000,000 organisms under the circumstances of the experiments. The results indicate that the simple *in vitro* test recommended should suffice for assaying the sensitivity of strains from patients to be treated with streptomycin.

TABLE 1

RELATION BETWEEN MEC* ON LEVINTHAL AGAR AND MED† SUFFICIENT TO PROTECT MICE AGAINST 20,000,000 ORGANISMS PER MOUSE

Strain No.	Sensitive Strains MEC	Sensitive Strains MED	Resistant Strains MEC	Resistant Strains MED
1	1.1	39.0		
1a			525.0	> 630.0
1b	13.0	39.0		
2	1.6	19.5		
2a			73.0	315.0
3	1.1	19.5		
3a			> 525.0	> 1,575.0
4	0.8	19.5		
4a			1,078.0	> 1,575.0

* Minimum effective concentration *in vitro* units/cc. of culture media.

† Minimum effective dose units per mouse required for protection of 50 per cent of animals.

The results of earlier studies of the protective capacities of serum and sulfadiazine against lethal Type b *H. influenzae* infections in mice have been published (*1*). Experiments were designed to compare the protective power of streptomycin alone and in conjunction with sulfadiazine with that obtained by specific serum along with sulfadiazine. The results are tabulated along with those reported previously.

Protective Agent	*Maximum LD_{50} Protection*
Sulfadiazine	10,000
Specific rabbit serum	10,000–100,000
Sulfadiazine and serum	1,000,000
Streptomycin	100,000,000
Streptomycin and sulfadiazine	100,000,000

It is seen that the protective capacity of streptomycin alone equals that obtained by combining its action with sulfadiazine. This degree of protection by streptomycin was exhibited in four experiments in which two different strains of Type b *H. influenzae* were tested. Protection beyond 100,000,000 LD_{50} has not been explored, but the data show clearly that streptomycin alone is more effective against massive *H. influenzae* infections in mice than serum used in conjunction with sulfadiazine.

The foregoing observations have led us to treat [H.] influenzal meningitis patients with streptomycin alone. The results, which will appear elsewhere, have been encouraging.

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Urinary Recovery of Penicillin After Oral Administration With Antacids and Buffers

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The importance of neutralizing gastric acidity [for] the therapeutic success of orally administered penicillin has been unquestionably established (*1*). Earlier studies on penicillin absorption and excretion have proved that most of the orally administered penicillin is destroyed by stomach acidity (*1, 9*). The presence of small amounts of penicillin in the urine and in the blood after oral administration indicated a potential penicillin absorption from the intestines; moreover, a corresponding increase in both urine and blood penicillin levels has been produced by the oral administration of larger doses of this antibiotic (*

These observations suggested that oral therapy [with] penicillin is possible, once sufficient penicillin intake has been assured and its destruction by gastric acidity eliminated. The extent to which the gastric acidity is neutralized determines the efficacy of using a particular buffer or antacid for the absorption of penicillin. Several antacids (*10*), buffers (*10*), and [others] (*4, 6*) in fluid form or in gelatin capsules have been used to fulfill this purpose. The results reported in the literature are somewhat confusing and conflicting (*2, 3, 5, 8*). In most instances the investigations were carried out by comparing the responses of [subjects]

eral individuals, and the results of penicillin concentration in both urine and blood have been shown to vary considerably (*3*).

To compare the effectiveness of buffers and antacids by their known ability to neutralize gastric acidity, and to prevent individual variations, we found it necessary to use only one normal individual (male) in our series of investigations. Some of the tests were repeated on other persons to check the findings.

The purpose of this report is to indicate the results of a study of the value of various buffers and antacids recommended for the oral administration of penicillin by the determination of the quantity of penicillin excreted in the urine over a period of six hours. In a future report these findings will be supplemented with blood penicillin levels, using the same antacids and buffers.

TABLE 1

THE BUFFERS AND ANTACIDS STUDIED WITH THEIR DOSAGES

Buffer or antacid	Quantity taken orally in 200 cc. of water
Sodium citrate U.S.P.	2 grams
Cottonseed oil in gelatin capsule	1 cc.
Aluminum gel*	8 cc.
Aluminum hydroxide gel*	7½ cc.
Sodium bicarbonate U.S.P.	2 grams
Calcium carbonate U.S.P.	2 grams
Sodium chloride U.S.P.	1.7 grams
Antacid powders containing a mixture of sodium bicarbonate, colloidal kaolin, magnesium trisilicate, and bismuth subcarbonate	2 grams

* Two different brands.

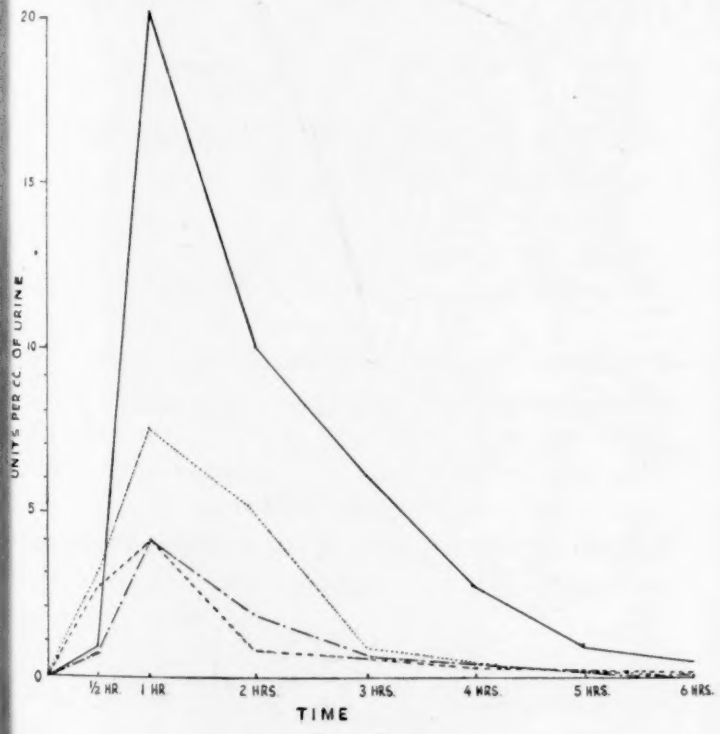

FIG. 1

Sodium bicarbonate
Sodium chloride
Sodium phosphate (dibasic)
Sodium-citrate

Table 1 lists the dosages of the buffers and antacids under study.

In each instance, 25,000 units of sodium penicillin dissolved in the aqueous solution or suspension of the buffer or antacid were taken by mouth approximately two hours after breakfast. The subject under study was instructed to abstain from food and liquids for at least two hours. To avoid any interference with subsequent doses of penicillin, the above buffers and antacids were distributed over a period of several months, so that only one of the compounds was taken either once a week or every other week.

Urine was voided after one-half hour and thereafter at hourly intervals for six hours. The volume of urine was measured and the samples kept in glass-stoppered bottles at a temperature of 3° C. until assayed. Since detectable quantities of penicillin were rarely found in the urine after the sixth hour, no assays were done after that period.

Penicillin was assayed by the Food and Drug Administration cylinder-plate method as of January 1945, using *Staphylococcus aureus* 209 and comparing the unknown samples with a standard penicillin curve prepared daily.

The urinary excretion of penicillin obtained with the various buffers and antacids is shown in Figs. 1 and 2.

The penicillin potency expressed in Oxford units

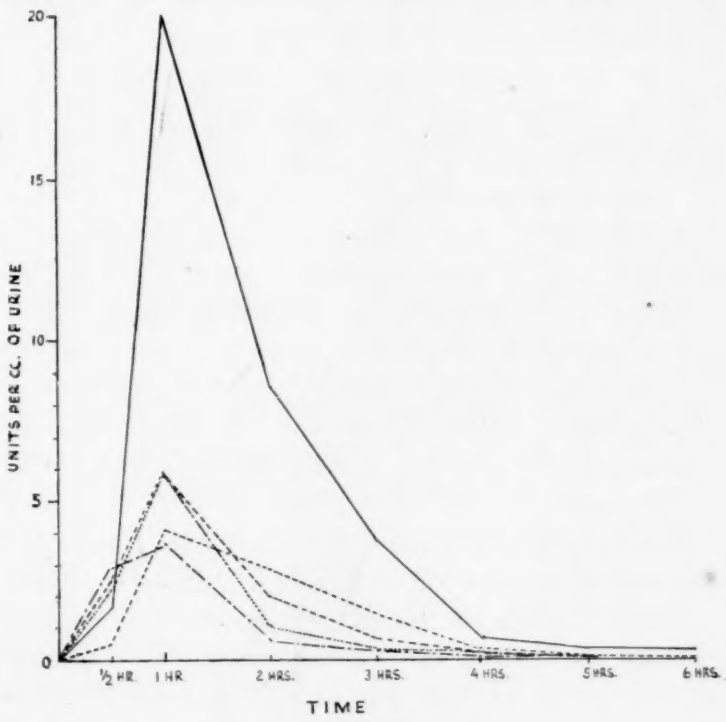

FIG. 2

Antacids containing sodium bicarbonate, colloidal kaolin, magnesium trisilicate, and bismuth subcarbonate
*Aluminum gel
*Aluminum hydroxide gel
Calcium carbonate
Cottonseed oil

*Two different brands.

per cubic centimeter of urine is plotted against time, and the one-half-hour sample includes the volume of urine present in the bladder prior to the test. The value given for each point on the graph is the average of two determinations. Physiological saline has been used as a control, and the urinary excretion of penicillin confirms the statement that penicillin administered without buffer or antacid is absorbed to a slight extent (*9*).

When penicillin is combined with an antacid powder containing a mixture of sodium bicarbonate, colloidal kaolin, magnesium trisilicate, and bismuth subcarbonate, or sodium bicarbonate alone, the urinary excretion of penicillin surpasses that observed by any substance of the group studied. We have been able to obtain reproducible urinary penicillin excretion curves, when a combination with the antacid powder mixture was used. The same results have been found not only on the subject under study but also on several other male individuals.

Table 2 summarizes the total percentage recovery of penicillin in the urine after six hours by multiplying the values of the unit potency per cubic centimeter of urine by the volume of urine. From these values it is again apparent that the maximum excretion occurs when antacid combinations or sodium bicarbonate alone have been used.

TABLE 2

PERCENTAGE RECOVERY OF PENICILLIN IN URINE

Material administered	Per cent	Units
Aluminum gel	2.0	500
Aluminum hydroxide gel	2.6	650
Calcium carbonate U.S.P.	2.6	650
Sodium phosphate (dibasic)	3.20	800
Cottonseed oil in gelatin capsule	2.5	625
Sodium chloride U.S.P.	1.9	475
Sodium citrate U.S.P.	5.0	1,250
Sodium bicarbonate U.S.P.	8.7	2,175
Antacid powders containing sodium bicarbonate, colloidal kaolin, magnesium trisilicate, and bismuth subcarbonate	9.0	2,250

Therapeutically, the use of sodium bicarbonate has its limitations, due to the danger of alkalosis. However, with antacids containing several buffers and smaller amounts of sodium bicarbonate, no apparent change in the urinary hydrogen-ion concentration has been observed.

Antacid powders used in combination with penicillin produced a unit potency of penicillin excretion of 20 Oxford units/cc. of urine within the first hour (Fig. 2), whereas the maximum for aluminum hydroxide gel was 4–6 units/cc. and for sodium citrate, 7.5 units/cc. Furthermore, the total penicillin recovery after oral administration with antacid powders exceeds that observed with any of the group studied.

The penicillin values obtained from the urinary excretion do not necessarily infer a corresponding blood level. It is merely suggested that this may be the case.

The necessity of restricting our investigations to males became evident when it was found impossible to obtain reproducible characteristic penicillin urinary excretion with the females studied. Similar findings in females have also been reported by Perlstein, *et al.* (*8*), who found an unexplainable maximum excretion in the eighth hour. The mechanism of urinary clearance would seem to vary in males and females. A similar difference in kidney physiology between males and females has been reported by Smith (*11*). Moreover, Oster (*7*) has recently found a histochemical difference in the kidneys of male and female rats.

Summary. Combinations of sodium bicarbonate, colloidal kaolin, magnesium trisilicate, and bismuth subcarbonate with penicillin produce a higher penicillin titer in the urine than the various antacids and buffers recommended for oral penicillin therapy.

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Transmission of *Salmonella enteritidis* by *Pulex irritans* and *Ctenocephalus canis*

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The possibility of transmitting an infection by means of *Pediculis vestimenti* as a host of *Salmonella enteritidis* has been studied by Huang and Lien (*1*).

Later, Steinhaus (*3*) isolated the following Salmonelleae from insects: *Eberthella pyogenes* from *Neobius fasciatus* var. *fasciatus* and *Eberthella insecticola* from *Conocephalus fasciatus* var. *fasciatus*, *Oncopeltus fasciatus*, and *Loxa variegata*.

More recently, Parker and Steinhaus (*2*) proved

that *Dermacentor andersoni* becomes infected with *S. enteritidis* by ingesting the germs. These can be found in the feces of the vector, which is able to transmit the infection to guinea pigs 35 days after the contaminated meal has been ingested. It is possible to transmit the infection to the descendants of the tick by means of their eggs. Supported by the fact that epizootics caused by *S. enteritidis* can develop in guinea pigs inoculated with *Ripicephalus sanguineus,* the authors have suggested the possibility of natural infection of the latter with such Salmonella.

In this laboratory guinea pigs were injected with several groups of *B. annulatus, B. microplus,* and *A. persicus,* and colonies of *S. newport, S. enteritidis, S. typhimurium,* and *S. poona* were isolated from the spleens of some of the guinea pigs. It it believed that the infection was due to other causes than the existence of Salmonella infection in the ticks in the experiment.

Experimental studies on infection and transmission of *S. enteritidis* by *Pulex irritans* and *Ctenocephalus canis* have recently been undertaken by us. White mice were infected intraperitoneally with *S. enteritidis.* After 24 hours, when the animals showed clear signs of acute disease and blood cultures made were positive to Salmonella, fleas of the species mentioned above were fed on the infected mice. It was possible to isolate *S. enteritidis* 24, 48, and 96 hours after the fleas were fed. The isolation was carried out by culture of a portion of the grounded fleas on the usual Salmonella media. Cultures made from the feces of the fleas 24 hours following infection were found negative to Salmonella.

In another experiment fleas infected 24 and 48 hours before, and then maintained fasting for 24 hours, were used. These were fed on 12- to 14-day-old mice, since younger animals are more susceptible. All the mice showed no symptoms after one month. Cultures made with ground spleen of the animals on the 1st, 2nd, 4th, 6th, 20th, and 30th days after being bitten were negative.

Another lot of fleas were infected in the same way and then fed on two 28- and 30-year-old adult men. After a month of clinical observation we were not able to note any symptoms, and repeated cultures made from their feces were negative.

The negative results obtained in attempts to transmit *S. enteritidis* infections by the bite of several fleas infected with such germs seem to demonstrate that if such infection is produced, it is so slight that it cannot be diagnosed either in man or in young mice.

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The Eurasian Continental Glacier of the Late Pleistocene

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Three-quarters of a century ago Prince Kropotkin reported his discovery of glacial erratics and of ancient moraines which indicated the former presence of a continental glacier in eastern Siberia (*3*).

Against the view of Lyell, current at the time, that such evidence could be explained by the "drift" of icebergs, Kropotkin offered cogent arguments. That the observations of so competent and reliable an explorer-geologist were generally disregarded is explained by the powerful influence of the well-known Russian climatologist, Woikov (*6*), and the highly placed geologist, Tscherski (*5*), each of whom acted to strongly discredit them. Woikov wrote in 1881:

> Geologists are agreed that at least since the Pliocene the great climatic features of the Asiatic Continent have remained essentially unchanged. The high mountains and plateaus were there and the interior portions of the continent were therefore cut off from the moist regions of the north, west and south. . . . Such an aridity naturally excludes and excluded glaciers, with the exception of some quite small ones in the high mountains.

Despite the influence of this oracular pronouncement of Woikov, some Russian explorer-geologists in Siberia continued to collect evidence of a past glaciation, and the outstanding geologist, W. A. Obrutschev, for 40 years piled up the evidence, until in his "Geologie von Siberien," published in 1926,[1] he supplied a short summary account of a Siberian glaciation. Four years later he treated the subject much more fully and supplied a sketch map of the glaciated area (*4*). After another seven years (1937) there appeared the first volume of the *Great Soviet atlas,* in which large-scale glacial and soil maps were included.[2]

Due to World War II, which opened as this volume was issuing, it is likely that glacialists are only beginning to know of these Eurasian continental glaciations,

[1] This appeared in *Fortschr. Geol. Paleontol.*, 1926, **15**, 381–399.

[2] This *Great Soviet world atlas,* Pt. I: *Maps of the world,* was prepared under the cooperative editorship of A. F. Gorkin, O. J. Schmidt, V. E. Motylef, M. V. Nikitin, and B. M. Shoposhnikov. The director of the Scientific Editorial Institute was V. E. Motylef. The soil map is Plate 40–41–42, and the glacial map, Plate 90–91.

Three years later there appeared a translation into English of the titles and subtitles of this superb work which has no parallel in any other country (*Great Soviet world atlas.* Pt. I. Trans. by Andrew Perejda and Vera Washburne under the direction of George B. Cressey, Department of Geology and Geography, Syracuse University, Syracuse, New York. Ann Arbor, Mich.: Edwards Bros., 1941).

and it has seemed to me best to bring out for the benefit of English-speaking geologists some account of the latest of these glaciations, interpreted with regard to the nature and behavior of such glaciers, as has been learned by recent studies of the still existing ones, and particularly that over Greenland (*1*).

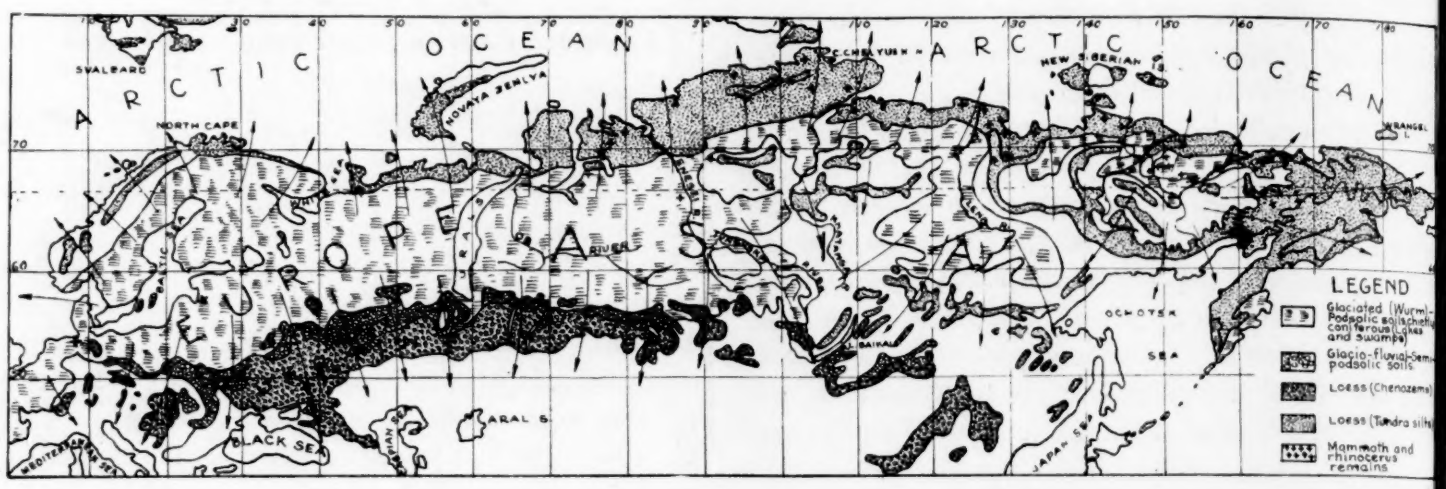

FIG. 1. Map to show the area covered by the latest Eurasian continental glacier of the Pleistocene, with its surrounding zones of outwash and loess. (*After* the world soil map, Plate 40–41–42, of the *Great Soviet world atlas*, but with additional material.)

Of the four glaciations already recognized for the European region, three have now been definitely identified in Siberia. The next to the latest, the *Riss,* was the most extended. The latest, the *Wurm,* which with little doubt corresponds to the Wisconsin in North America, is much the easiest to delimit, since it is so recent as still to be poorly drained, covered over as it is by lakes and swamps. Since lakes are so short-lived in a geological time sense, none have survived from the three earlier glaciations, and the areas in which the deposits of these earlier glaciers are found are perfectly drained. Their deposits are also in part buried under the outwash and surrounding loess aprons of the *Wurm,* due to the outblowing winds of continental glaciers and to the alternation of summer and winter. The outwash is an area of meltwater deposition during the warm seasons and one of active deflation during the succeeding cold ones.

The area of podsol (Fig. 1) with its lakes and swamps is the area once covered by the *Wurm* glaciation. That of semipodsols, which borders it, is largely outwash (sands and gravels), as is clearly indicated by the part included from Europe. This was already well known (*2*).

Outside the outwash and surrounding it as an outer apron to the glacier is the loess zone. On the southern border this is the area of Czenozems, recognized as an eolian deposit. This is followed in continuous deposit through southern Europe, the wheatlands of the Ukraine, and across the European border into the wheatlands of south-central Siberia. On other borders of the Eurasian *Wurm* glaciation the loess is represented by the tundra silt, and in mountainous areas by the silt of the "mountain tundra," since loess is there retained only on crests, due to effective slope erosion.

That the tundra silt is a Pleistocene eolian deposit is clearly indicated by the entombed bones of the air-breathing Pleistocene mammals (mammoth, rhinocerus, equus, bison, etc.),[3] by the embedded trees (birch, larch, etc.), and also by moss and turf.

The map relationships of the outwash and loess required the presence everywhere of outward-blowing winds from the glacier (the glacial anticyclone), and curving lines have been added to the map to make this clear. By this anticyclone system the glacier is nourished from its central area of downdraft, which pulls down the water locked up in the ice needles of the cirri. This source in the upper layers of the atmosphere makes the glacier quite independent of the air circulation at and near the surface of the ground outside, even if in Pleistocene time the region had been arid, as Woikov had contended.

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[3] Some of the localities where mammoth or rhinocerus remains have been found entombed have been entered upon the map of Fig. 1, after maps by Tolmachoff (*Trans. Amer. phil. Soc.*, 1929, **23**, 20) and Osborn.

News and Notes

About People

O. J. R. Howarth is retiring from his position as secretary of the British Association for the Advancement of Science, which office he has held since 1909. His successor will be D. N. Lowe, who served as assistant secretary before the war and who has only recently returned from government service.

Alfred S. Romer, curator of Vertebrate Paleontology and director of the Biological Laboratories, Harvard University, will become director of the University's Museum of Comparative Zoology on 1 September. Prof. Romer will succeed the late Thomas Barbour. Henry B. Bigelow has served as acting director since last January.

Loren C. Eiseley, professor and head of the Department of Sociology, Oberlin College, is visiting professor of anthropology at Columbia University during the summer session.

Mildred Trotter has been promoted to professor of gross anatomy at Washington University School of Medicine, St. Louis.

Thomas Scott Sutton, of the Department of Animal Husbandry at Ohio State University, has been appointed director of the newly-established Institute of Nutrition and Food Technology to be operated by the University and the Ohio Agricultural Experiment Station at Wooster, Ohio.

William Lee Hart, medical director of the Eighth Service Command, U. S. Army, during the war, was awarded a L.H.D. degree by the Southwestern Medical Foundation at the commencement exercises of its Medical School on 10 June.

Joseph F. Sadusk, Jr., formerly executive officer of the United States of America Typhus Commission, is returning to the Department of Internal Medicine, Yale University.

Charles N. Frey, director of Scientific Relations, Standard Brands, Inc., New York City, received the Doctor of Science degree from Michigan State College on 8 June.

R. T. Crawford, of the Berkeley Astronomical Department, University of California, retired from astronomical service and became professor of astronomy emeritus and director emeritus of the Students' Observatory on 1 July 1946.

Raymond D. Mindlin, associate professor of civil engineering at Columbia University, where he has been a member of the staff since 1932, has recently been awarded the Medal for Merit for his wartime work in the development of the radio proximity fuse.

Prof. Mindlin was largely responsible for the mechanical design of the radio tubes in the proximity fuse. Following completion of this development in 1943, he became head of a mathematics group which participated in the design of an electromechanical director for the control of naval antiaircraft fire. In addition, he made special investigations and reports for the Bureau of Ordnance, Navy Department.

Roy G. Bossert will return to the faculty of the Chemistry Department, Ohio Wesleyan University, as an associate professor in September. Dr. Bossert taught at Ohio Wesleyan from 1937 until 1944, but has been stationed at Mellon Institute, Pittsburgh, for the past two years.

Clyde Eyster, head of the Botany Department, University of South Dakota, has been appointed research plant physiologist at Kettering Foundation for the Study of Chlorophyll and Photosynthesis and associate professor of plant physiology at Antioch College, Yellow Springs, Ohio, effective 1 September 1946.

Announcements

The McNeeley-Pepper Bill to provide $100,000,000 for cancer control was defeated by a vote of 139 to 126 in the House Saturday, 27 July. Opponents of the measure said that in general they approved of the objectives set forth, but they thought that it was too loosely drawn to accomplish its goal. Several said that the present program of the National Cancer Institute and the United States Public Health Service should be expanded since their programs are already under way.

The Agricultural Institute of Canada held its 26th annual meeting at Macdonald College, Quebec, on 24–27 June. The scientific sessions covered the Agricultural Engineering, Horticulture, and Soils Groups of the Institute together with the Canadian Societies of Animal Production, Agricultural Economics, and Phytopathology. S. B. Fracker, research coordinator, Agricultural Research Administration, U. S. Department of Agriculture, spoke on "The Organization of

Agricultural Research," and J. E. Carrigan, dean of the College of Agriculture, University of Vermont, spoke on "The Organization of Agricultural Extension" at the General Open Session.

Numerous openings are available in the Naval Ordnance Laboratory for physicists, mathematicians, engineers, and technicians, both in Washington and at other stations. The classifications range widely from P–1, at $2,644.80 per annum, to P–8, at $9,975.00 per annum under the new Federal pay scales. Complete job descriptions are contained in *Scientific Personnel Bulletin,* Employment Series No. 2, dated 1 June 1946. Applicants should submit Form 57 to: Navy Department, Certification Unit, Building L, Room 2209, Washington, D. C. (for positions in Washington); and U. S. Navy Office of Research and Inventions, Branch Office, 150 Causeway Street, Boston, Massachusetts; 1 Park Avenue, New York 16, New York; America-Fore Building, 844 Rush Street, Chicago 11, Illinois; or 616 Mission Street, San Francisco 5, California (for positions outside of Washington, D. C.).

Since 1920 the Naval Ordnance Laboratory has grown from a small research group of 14 or 15 scientists to an organization which now employs over 1,500 persons. The new $16,000,000 plant at White Oak, Maryland, northeast of Silver Spring, will be occupied sometime during the summer. Many of the best residential areas of the Washington suburbs are within five miles of the 938-acre site at White Oak.

The Genetics Society of America, through its Committee on Aid to Geneticists Abroad, has recently called attention to the plight of Prof. Wieczeslav Savicki (sometimes transliterated Savitsky) and his wife, E. I. Haretchko-Savitzkaya, who are at present interned in the Displaced Persons' Camp operated by UNRRA at Oberammergau, Germany. According to information in the hands of the Genetics Society, Prof. Savicki, who was formerly employed at the University of Kiev as professor of genetics, is in danger of being returned to the Ukraine where, according to him, they would be executed "because they hold the views of Western World geneticists." Prof. Savicki is appealing for help to get to the United States. His address is: Oberammergau, Bavaria, Germany, UNRRA Team 568, Ausländerlager.

The British Association for the Advancement of Science met for only one day this year on 20 July in the hall of the British Medical Association, Tavistock Square, where the president, Sir Richard Gregory, delivered his address, "Civilization and the Pursuit of Knowledge." Next year when the Association meets at Dundee, it is hoped that attendance will again approximate the prewar level of 1,500.

Tracerlab, Inc., 55 Oliver Street, Boston, has been organized by a group of young physicists and engineers, some of whom were associated with the Radiation Laboratory, Massachusetts Institute of Technology, to develop and manufacture instruments, to make radioactivity analyses, and to offer consultation services in various phases of radioactive tracer research. The premises in Boston house complete, modern research and analytical laboratories, together with manufacturing facilities and offices.

The Department of Chemistry, University of Pittsburgh, has published its history, which now extends over a period of 80 years. More than 550 publications emanating from the Department are listed. There are 525 graduates in all, and during the period of 1913 on, 164 Ph.D.'s have been granted. The publication lists the names of the candidates and the titles of the theses. The compiler of the work is Alexander Silverman, professor of inorganic chemistry and head of the Department, who has served in the department for 40 years.

A world-wide exchange of views among scientists on the problems of atomic energy control has been initiated by the Federation of American Scientists through its Committee for Foreign Correspondence. The Federation is undertaking to establish direct contact by mail between scientists in this country and those in all parts of the world. By this means the Federation aims not only to strengthen bonds of friendship but also to encourage the development of a concerted attack on the difficulties which stand in the way of peaceful, international control of atomic energy.

The present lack of mutual understanding on this question may, the Federation believes, "dangerously strengthen national isolationism at a time when world peace and security depend upon a rapid extension of international cooperation." They hope to send published material abroad which will reflect the thinking and feeling of American scientists. In this way, they say, "we can convince scientists of other nations that their colleagues in America have joined forces to promote international cooperation and that they are determined in particular to avoid an atomic armament race. We can show what has been accomplished in this country toward this goal and can give hope that a constructive solution, acceptable to all peoples, is possible. The extent to which literature can be sent for these purposes depends on the support of all interested persons."

The Federation reports that more than 7,000 letters and questionnaires have been sent to American scientists, and in return the names and addresses of over 1,000 foreign scientists from about 40 countries have been submitted to the Committee.

The Federation points out that the success of its program depends on the participation of the numerous scientists in all fields, both inside and outside the Federation, who have not yet been contacted by the Committee. Individuals are urged to give their much needed help by: (1) sending to the Committee, preferably on the standard questionnaire form obtainable by sending a postcard to the Committee, a list of foreign scientists to whom they would be willing to write; (2) sending to the Committee the names and addresses of American friends who know foreign scientists; (3) sending contributions for the support of the Committee's work. The cost of republishing the required material and mailing it abroad will overtax the funds of the Federation. Address A. S. Bishop, chairman, or Oliver Johnson, treasurer, The Committee for Foreign Correspondence, Box 615, Berkeley, California.

"Magnetism and the Structure of Catalytically Active Solids" will be the subject of a series of lectures and discussions by Pierce W. Selwood on 3–7 September, according to an announcement by the Chemistry Department, Northwestern University. This series is designed especially for research workers interested in the structure of catalytically active inorganic solids and in related problems. The lectures will emphasize the part played by magnetic susceptibility measurements in modern structural inorganic chemistry.

Registrants are invited to bring their own samples for measurement, in which case they are urged to communicate with Prof. Selwood in advance. Standard samples such as gamma-alumina, chromia-alumina, nickel-kieselguhr, copper, chromite, etc. will be on hand.

Topics to be covered include the following:

Tuesday, 3 September, 2:00 P. M.—General Principles of Magnetochemistry; *Wednesday,* 4 September, 10:00 A. M.—Instrumentation; *Thursday,* 5 September, 10:00 A. M.—Free Radicals and Complex Compounds; *Friday,* 6 September, 10:00 A. M.—Susceptibility Isotherms; *Saturday,* 7 September, 10:00 A. M.—Curie Point Diagrams.

Northwestern University will provide housing for registrants, the number of which will be limited. The registration fee, including housing, is $125. Inquiries should be addressed to Robert K. Summerbell, Chairman, Chemistry Department, Northwestern University, Evanston, Illinois.

The AAF School of Aviation Medicine, Randolph Field, Texas, has been affiliated with the AAF Air University, Maxwell Field, Alabama, according to an announcement from the Headquarters of the Army Air Forces. Recent and contemplated developments in extremely high-altitude, high-speed flight, with their concomitant increased stress and high degree of specialization, and renewed emphasis on the importance of research in the services, have increased the responsibilities of the School and widened the scope of its interests. To provide more adequate facilities to meet these increased problems in aviation medicine, research will be conducted in the following basic and clinical sciences: biophysics, pathology, pharmacology and biochemistry, physical fitness, physiology, psychology, statistics, dentistry, medicine, neuropsychiatry, ophthalmology, and otolaryngology.

Inquiries regarding civilian or military positions are invited and should be addressed to the Commandant, AAF School of Aviation Medicine, Randolph Field, Texas.

A technical committee of the American Standards Association, working to set up an American Standard Practice for the basic procedures used in certifying products to the public, met on 26 April in New York City to work out a final draft of the standard. Increasing use of such procedures is being made in the marketing of consumer goods. The development of a standard practice for the protection of the public was proposed to the ASA by the Association of Consulting Chemists and Chemical Engineers after the latter had studied the problem of public pronouncements of approval of commodities and found practices to vary from valid to invalid with no means of assuring the public of validity.

Among those present at the meeting were representatives of the ACCCE, the National Bureau of Standards, the American Society for Testing Materials, the Federal Trade Commission, the National Electrical Manufacturers Association, the National Association of Purchasing Agents, and the American Council of Commercial Laboratories.

Discussion centered on the criticisms of, and comments on, a previously circulated, tentative standard that had been received from groups concerned with the certification of industrial and consumer goods and services. In general these letters showed widespread approval of the project. They included constructive criticisms received from members of the legal and advertising professions and from trade associations representing the electrical, gas, lumber, and other industries. They also furnished valuable suggestions for clarifying the statement of its purpose and for certain changes in the provisions.

The committee will meet during the summer for a final check on modifications before the standard goes to the ASA Council for approval as an American Standard. It will welcome further suggestions at this time, particularly from advertising and consumer groups. Those wishing to review the present draft

may obtain a copy of it in its uncorrected form by writing to the American Standards Association, 70 East 45th Street, New York 17, New York.

The American Book Center for War Devastated Libraries, Inc., has been organized in the combined interests of library and educational organizations, government agencies, and many other official and non-official bodies to coordinate action and pool resources for restocking the damaged or destroyed libraries in Europe and the Orient. The Center cannot purchase books and periodicals but must depend upon gifts from individuals or organizations. Each state will be organized to participate in the program through the leadership of a state chairman. Other chairmen will organize interest in the principal subject fields.

The scarcity of shipping space demands that all materials be carefully selected. Most urgently needed are books or periodicals (preferably those published within the last decade) that will be useful in research and necessary for the physical, economic, social, and industrial rehabilitation of Europe and the Far East. Although scientific and technological works are especially needed, important contributions and distinguished work in the fields of history, social science, music, fine arts, and literature are also desired.

The following types of literature cannot be used at this time: textbooks, out-dated monographs, recreational reading or materials of localized interest (such as may be found in popular magazines), and popular fiction or nonfiction of temporary significance. Only carefully selected federal or local documents are needed; donors are asked to write direct to the Center in regard to these.

Books and periodicals (tied together by volume with any missing issues listed) should be sent *prepaid* to: The American Book Center, c/o The Library of Congress, Washington 25, D.C. The Center cannot accept material which is sent collect, but if it should be impossible for the donor to assume the costs of transportation, he should notify the Center by card or letter and reimbursement will be made.

A Committee on Physiology Under Natural Conditions was proposed and approved at a Conference on Physiological Research on Animals in Their Natural Environments, held in Washington, D. C., 26 April, under the auspices of the National Research Council. Under the chairmanship of Laurence Irving, a program of papers by the following interested biologists was presented at the Conference: Laurence Irving and P. F. Scholander, Swarthmore College; Sir Hubert Wilkins; Alfred C. Redfield, Woods Hole Oceanographic Institution; A. E. Parr, American Museum of Natural History; W. H. Forbes, Fatigue Laboratory, Harvard University; and August Krogh, University of Copenhagen.

Because of the complexity of physiological methods and recent needs for more practical work, it was felt that research in comparative physiology and physiological studies under truly natural conditions had not received adequate attention. Availability of physiological methods suitable for the field, especially those developed by Dr. Scholander and his colleagues, has increased the scope of projects and sizes of animals that can be studied. It was felt that this type of investigation would refresh the educational system and stimulate interest among young physiologists.

An early meeting of the above-mentioned Committee has been scheduled. Communications upon the subject are invited and may be addressed to Dr. Laurence Irving, Swarthmore College, Swarthmore, Pennsylvania.

"The Use of Radioactive and Stable Isotopes in Biological Research" will be the topic of a symposium at the University of Wisconsin soon. The date has not been announced because security releases have not yet been cleared. It is hoped that all groups using radioactive and stable isotopes in carrying on research can be invited to participate formally in the symposium. Every phase of biological research will be represented on the program. Further announcements will be made when a definite date can be set.

Recent Deaths

Ulric Dahlgren, 65, professor emeritus of biology, Princeton University, died on 30 May.

Howard W. Starkweather, 55, director of research in the fields of elastomers and fine chemicals at the Jackson Laboratory of E. I. du Pont de Nemours and Company, died on 18 May.

Ali A. Hassan, 86, geologist and mining engineer, died on 7 June. He was educated at the Universities of Vienna, Cracow, and Leopole, and was a member of the International Geological Congress.

Benjamin Freeman Kingsbury, 73, professor emeritus of histology and embryology, Cornell University and since 1941 guest professor of anatomy, University of North Carolina, died on 8 July in Chapel Hill following an illness of several weeks.

Alexander Alexandrovich Bogomolets, 65, dean of the Institute of Experimental Biology and Pathology, Kiev, died on 20 July. Dr. Bogomolets was the president of the Ukrainian Academy of Sciences and the discoverer of the antireticular cytotoxic serum known as ACS.

Letters to the Editor

Iodine as a Cytological Stain

The use of iodine as a staining reagent in cytological work has apparently never been very carefully explored. It has been employed, however, as a test stain to demonstrate the presence of glycogen (Lee, 1937) and amyloid (McClung, 1937) and thus has some value as a cytochemical reagent. Presumably also on the basis of the precipitation reaction produced by choline derivatives (Greiss and Harrow, 1885; Rosenheim, 1905; Booth, 1935) it should have some value as a neurological stain. Although this assumption may be entirely fallacious, it has been found that iodine in potassium iodide solution (Lugol's solution) can be used successfully as a staining reagent. When applied to fresh frozen sections of nervous tissue such as brain material, it is found to stain selectively a host of exceedingly minute bodies scattered throughout the cytoplasm and along the processes of the neurone. These bodies can be seen clearly only with the oil immersion objective. Their nature is also uncertain, but for the present they may be designated simply as periodide bodies. Similar organelles are present in some other tissues, such as liver and pancreas, which have been investigated in a preliminary fashion.

In like manner, if iodine is applied to fresh teased muscle preparations, it will stain the nerve end organs and make evident the characteristic features of these structures, namely, the sole plate, the granules of Kuhne, and, to some extent, the periterminal net. While the use of iodine as a stain for nerve endings has certain disadvantages it also possesses some distinct advantages, such as speed of application, and it is hoped it will make a staining reagent of considerable technical value. Full details of the methods employed in using the iodine staining reaction will be given in a forthcoming article.

F. B. Adamstone and A. B. Taylor
University of Illinois

DDT and the Black Widow Spider

Occasionally, under favorable conditions, a considerable concentration of black widow spiders (*Latrodectus mactans*) may occur around a single dwelling. This results from the "ballooning" method of dispersal employed by the young spiders on emergence from the egg sac. With the wind in the right direction and other conditions favorable, a house may be treated to a shower of spiderlings, many of which will find suitable locations, establish their webs, and grow to maturity. I have seen houses with black widows behind every shutter and drain pipe, around the foundation, in cellar windows, etc. While the risk is not great, due to the shy and retiring nature of the spider, it is just as well to exterminate them, particularly if young children are present.

Since the common insect sprays are ineffective and lethal substances, such as hyrdogen cyanide are too dangerous or difficult for common use, there has been to date no satisfactory method of eradication short of hunting out and destroying each individual spider. This is always very difficult, as the spider tends to make her retreat in the deepest hole or crack available.

To test the action of DDT a number of mature black widow females were collected. One was placed in an up-ended, open cigar box fixed in a retort stand over a pan of water (to prevent the escape of the spider). The spider made her characteristic irregular web through the box and out to the retort stand. A 10-per cent solution of DDT in kerosene was sprayed very lightly on the outer part of the web, care being taken not to hit the spider or the inner part of the web where she had her retreat. After about 24 hours the spider was observed halfway down the web with the legs constantly making an unnatural twitching motion. The next day she had dropped from the web and was dead. Without additional spraying another spider was placed in the same web and in a couple of days was dead. Four additional spiders placed in the web also died.

As a result of this experiment it may be said that a 10-per cent solution of DDT in kerosene sprayed on the web is lethal to the black widow spider and that the effect of one spraying lasts for some time. This, then, should prove to be a safe and sure method of eradication.

Walker Van Riper
Colorado Museum of Natural History, Denver

Fairy Shrimps in California Rice Fields

Branchiopod crustaceans have been of interest to zoologists for many years, chiefly because of their phylogenetic significance. These have a wide distribution in various parts of the world as inhabitants of lakes, streams, and especially small ponds. Recently a charge has been placed against a member of this group—the genus *Apus*—as being of some economic consequence to the rice growers in the Sacramento Valley of California. Growers have occasionally seen *Apus* in the rice checks, but no damage has been claimed until during the season of 1946.

The first report of damage by *Apus* was received on 31 May 1946 from L. L. Davis, of the U. S. Rice Experiment Station at Biggs, Butte County, California. Reports from Sutter County have also been received. Upon investigation it was found that *Apus* were present in many rice checks and in such numbers that their presence was of definite significance. The damage by these animals is twofold. The young plants are attacked shortly after germination; young leaves are chewed off at the base and float free on the surface. Subsequent wind action brings the freed leaves into windrows against the dikes. A second damaging effect is that the silt is stirred up and the water kept in a muddy condition. As a consequence, sunlight penetration is prevented and poor growth of the plants results.

The undersigned would welcome reports of damage by

Apus or *Lepidurus* to plants as seen in this or any previous season.

A detailed illustrated report of the damage and results of experimental work on control will be published elsewhere.

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Asphyxiate and "Anoxiate"

I have had occasion to review the literature on anoxia (*Anoxia: its effect on the body.* Univ. Chicago Press, 1942). One chapter, albeit a short one, was entitled "Definition of Terms." In this chapter exception was taken to the unfortunate misuse of the terms asphyxia and anoxia, and an earnest effort was made to distinguish clearly between them. I contended strongly that during anoxia there is no accumulation of CO_2 in the alveolar air or, presumably, in the tissues of the body, because the hyperpnea produced by anoxia washes the CO_2 out of the lungs. In the conditions of asphyxia exactly the opposite obtains. Precision of explanation requires us not to use the same word for two distinctly different conditions. Accordingly I summarized my view as follows:

"The author believes that it is understood by many that in asphyxial conditions there is an accumulation of carbon dioxide in the lungs and in the tissues of the body. If this actually is the concept that many biologists have of asphyxia, it is not difficult to accept the distinction between anoxia and asphyxia previously mentioned; that is, anoxia designates a diminished supply of oxygen to the tissues, and asphyxia a condition of anoxia combined with an increase of carbon dioxide tension in the blood and tissues. If this distinction were generally accepted, it would do away with much misconception and would distinguish sharply between asphyxia and anoxia" (p. 6).

My distinguished friend and fellow physiologist, the late Yandell Henderson, did not entirely agree with me in the distinctions I made between anoxia and asphyxia. In his stimulating manner he took me mildly to task. One of his criticisms was that the term asphyxiated is firmly established in the literature and that there is no equivalent for this term when a condition of anoxia is actually meant. Granted that this be true, then let us create one: the equivalent would be "anoxiated."

It has seemed to me for some time that the term "anoxiate" (to "anoxiate" or "anoxiated") should have a definite place in our scientific language. It is, for example, quite incorrect to say that a man was asphyxiated because he ascended to such a great height that the oxygen tension was too low to sustain life. This man was not asphyxiated; he was "anoxiated."

I wish, then, to make an earnest plea that the term "anoxiate" be accepted by scientific writers (and perhaps later by laymen). In order for them to do so it is quite necessary, of course, for the editors of scientific journals not only to recognize this descriptive term but actually to encourage its proper use.

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Book Reviews

Principles of physics II: electricity and magnetism. **Francis Weston Sears. Cambridge, Mass.: Addison-Wesley Press, 1946. Pp. 434. (Illustrated.) $5.00.**

This book completes Sears' trilogy of texts for the two-year elementary course in physics at the Massachausetts Institute of Technology. Volume I, on Mechanics, Heat, and Sound, and Volume III, on Optics, were published last year. The present volume, like the others, is intermediate in difficulty and scope between the usual one-year elementary physics texts used at other schools and the specialized, advanced, undergraduate texts. At the beginning of this volume the proofs involve vector equations and integration; at the end, solution of simple differential equations.

A genius for clear explanation runs through the discussions, the derivations, and the beautiful diagrams in Sears' whole series. It falters only once in Volume II, in the half chapter on chemical emf's, which was not written by Sears himself but by a collaborating author. The treatment of the troublesome E and D, B and H, and their relation to atomic behavior and to surface and bulk effects, is the clearest the reviewer has yet seen in a text and should be used for reference by every physics teacher who has ever got lost among these vectors.

The book keeps roughly the traditional order of subject matter, proceeding from electrostatics and steady currents to magnetism, alternating currents, and electromagnetic waves and optical reflection and refraction. But the usual welter of units and viewpoints is brought here into a lucid, teachable orderliness. This improvement comes, first, from putting the fundamental particles at the focus of attention and deriving all from them—fields from electron interactions, poles from fields and currents, and so on; second, from holding to the rationalized mks system of units throughout; and third, from the final approach to the electric and magnetic vectors noted above.

The reviewer was less pleased by the poorly organized wastebasket chapter on "Electronics" at the end of the book and by the tabloid introductory paragraphs centered around nuclear energy. The latter were evidently hastily inserted just before publication and are, of course, already out of date. They contain several mistakes, such as the invention of the mythical element "triterium."

There are many typographical errors in the book, and Volta's first name is consistently misspelled. The treatment of discoverers in both text and index is capricious and shows a poor sense of values. The various right- and left-hand mnemonic rules seem more confusing than helpful. The phrase "seat of emf" and the unnecessary neologism "microhm" (sic) are annoying, though terminology is usually treated carefully and sometimes with illuminating asides.

The paper used in the book does not do justice to the half tones, but the page format is pleasingly open and readable.

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Pure cultures of algae: their preparation and maintenance. **E. G. Pringsheim. Cambridge, Engl.: At the Univ. Press; New York: Macmillan, 1946. Pp. xii + 119. (Illustrated.) $1.75.**

Students of the algae will welcome the appearance of this valuable little work on the methods and techniques of preparing and maintaining pure cultures of algae. The author's experience over a period of many years, involving thousands of experiments, and his close familiarity with the literature make this book an authoritative account in this little-explored field.

The subject is introduced by an historical summary of the development of culture methods. This is followed by chapters dealing with the choice and use of materials, selection of various liquid and solid media, methods of isolating bacteria-free cells, suggestions for the maintenance and use of pure cultures, and the culture of species belonging to the several taxonomic groups.

The book is especially valuable because of the critical discussion of the advantages and shortcomings of different methods, procedures, and media employed in pure culture work. The use of soil-and-water cultures as a preliminary step in securing bacteria-free cultures is highly recommended. The influence of such factors as temperature, illumination, glassware, and character of the water used in media on the growth of algae is given adequate space.

On the whole, the book is stimulating and suggestive of numerous problems yet to be solved, many of which have an important bearing on the ecological relations in the world of microorganisms.

NOLAN E. RICE
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Elon College, North Carolina

A textbook of biochemistry. **Philip H. Mitchell. New York: McGraw-Hill, 1946. Pp. xv + 640. (Illustrated.) $5.00.**

In about 600 pages of text material the author has included a surprisingly large and well-balanced body of information. Aside from a chapter on photosynthesis and a brief treatment of plant hormones, the emphasis is almost exclusively on animal biochemistry, with a definite clinical slant. Accordingly, the book would be well suited for medical school courses in biochemistry, but less so for more general courses.

The presentation is, in the main, quite clear. It was felt, however, that for a book of this nature too many names of uncommon substances of minor importance (e.g. robinose, stachyose, brassicasterol, etc.) were included in the early parts of the text, thus making it more difficult for the beginning student to assimilate the "meat" of these sections.

For the most part, the more recent developments in the field up to two years ago have been adequately covered. The newer concepts of metabolism gained through the use of plasmapheresis, isotopes, tissue-slice studies, etc. are well presented. Such rapidly expanding subjects as biological oxidations, chemotherapy, vitamins, hormones, and dietetics have been discussed in a concise, up-to-date manner. No mention is made, however, of the important work of Beadle, Tatum, and others with X-ray-induced mutations of *Neurospora*. These studies have provided valuable information on the intermediary stages of metabolism, and the genetically different strains have proven exceptionally useful for microassays of many vitamins and amino acids.

Relatively few errors, typographical or otherwise, were noted. The author consistently misspells riboflavin, niacin, and biotin by adding a terminal "e" to each. Also, niacin is stated to be synonymous with nicotinic acid and/or its amide; actually, niacin should designate only the acid, whereas the amide is properly termed *niacinamide*. In one instance free (elemental) iodine is called *metallic* iodine.

The book contains many charts and tables and a lesser number of diagrams and photographs. Subject and author indexes are included. Very few references are cited in the text, but at the end of each chapter the author lists various monographs, review articles, and a few selected papers on topics discussed in that chapter.

All in all, this text can be recommended as a readable, up-to-date first course in biochemistry.

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The principles and practice of tropical medicine. **L. Everard Napier. New York: Macmillan, 1946. Pp. xvi + 917. (Illustrated.) $11.00.**

World War II has been a great stimulus to the study of diseases in the tropics as well as to the publication of books on tropical medicine. Some have been comprehensive works covering the entire field, by single authors or groups of authors; others have been brief compendiums for rapid reference. Dr. Napier's book comes between these extremes. In his own words, he wishes it considered a textbook for students, practitioners, and public health workers.

The author justifiably explains his omission of smallpox, typhoid fever, tuberculosis, and diseases of the eye, and his inclusion of tularemia and certain cosmopolitan helminthic infections. He has kept the description of

laboratory procedures to a minimum, expecting the student to have textbooks available on this subject.

The background and development of this book are interesting and explain its particular value and its limitations. Dr. Napier was, until 1943, director and professor of tropical medicine of the Calcutta School of Tropical Medicine. There he had worked for over 20 years and had become the recognized authority on the clinical aspects and chemotherapy of kala azar. With the beginning of the war with Japan, he found it necessary to establish a course in tropical medicine for medical officers of the armed forces of Great Britain and the United States who had had no previous experience in this field. His book is largely based on his comprehensive review of tropical medicine at that time. The first volume was published by Thacker, Spink, and Company in Calcutta in 1943. At that time, however, he came to the United States and completed his work here, publishing it in one volume. For this reason, the Calcutta portion of the book was lithographed in the United States with certain minor revisions, and the new part of the work was added in identical type, producing a uniform volume.

The particular value of this work lies in its authorship by a man who has had a very extensive personal experience in a country where many tropical diseases exist. The chapters dealing with these diseases have been written from the point of view of his own experience, which may be considered highly authoritative, particularly from the British point of view. The chapters on diseases not present in India are the result of his extensive review of the literature and personal contact with authorities on those diseases and are also, in general, excellent in their presentation.

The principal limitation of the book is that the Calcutta portion could not be adequately revised to include discoveries made during the war. Such changes as were made had to be inserted in such a way as to cause the least possible change in the text, and in some places are slightly confusing to the reader.

In addition to the infectious diseases, which constitute the great bulk of the text, there are valuable sections on effects of tropical climate on health, on nutrition and nutritional diseases in the tropics, and on snakes and snake bite.

The book is profusely illustrated with maps, charts, line drawings of parasites, life cycles, and photographs, many of which are original. The four colored plates devoted to intestinal parasites, arthropods, malaria, and snakes are in general well done, although a parasitologist would object to the four-nucleate cyst of *Endamoeba coli* and to the omission of the egg of *Schistosoma japonicum*.

The reviewer considers this work one of the most valuable contributions to tropical medicine and feels that it should be a part of every medical library. It should be widely used both as a student textbook and as a guide to practitioners of medicine, both in the tropics and in the temperate zones.

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Scientific Book Register

BERRY, A. J. *Modern chemistry: some sketches of historical development.* Cambridge, Engl.: At the Univ. Press; New York: Macmillan, 1946. Pp. x + 240. $2.50.

CHADWICK, HENRY D., and POPE, ALTON S. *The modern attack on tuberculosis.* New York: Commonwealth Fund, 1946. Pp. 134. (Illustrated.) $1.00.

COKER, ROBERT E. (Ed.) *Research and regional welfare.* Chapel Hill: Univ. North Carolina Press, 1946. Pp. xvi + 229. $3.00.

COKER, W. C. (Ed.) *Studies in science.* Chapel Hill: Univ. North Carolina Press, 1946. Pp. 375. (Illustrated.) $3.00.

CROCKER, E. C. *Flavor.* New York: McGraw-Hill, 1946. Pp. vii + 172. (Illustrated.) $2.50.

CURTIS, ARTHUR HALE. *A textbook of gynecology.* (6th ed.) Philadelphia-London: W. B. Saunders, 1946. Pp. xiv + 755. (Illustrated.)

GOLD, HARRY. (Ed.) *Cornell conferences on therapy* (Vol. I). New York: Macmillan, 1946. Pp. 3[illegible] $3.25.

HARRISON, SHELBY M., and ANDREWS, F. EMERSON. *American foundations for social welfare.* New York: Russell Sage Foundation, 1946. Pp. 249. $2.00.

HOSKINS, R. G. *The biology of schizophrenia.* New York: W. W. Norton, 1946. Pp. 191. $2.75.

HOWARD, WALTER L. *Luther Burbank: a victim of hero worship.* (Vol. 9, No. 5–6, *Chronica Botanica.*) Waltham, Mass.: Chronica Botanica; New York: G. E. Stechert, 1946. Pp. 299–522. (Illustrated.) $3.[illegible]

KOPAL, ZDENEK. *An introduction to the study of eclipsing variables.* Cambridge, Mass.: Harvard Univ. Press, 1946. Pp. x + 220. $4.00.

MARK, H., and WHITBY, G. S. (Ed.) *Scientific progress in the field of rubber and synthetic elastomers.* (*Advances in Colloid Science,* Vol. II.) New York: Interscience, 1946. Pp. xi + 453. (Illustrated.) $7.00.

MEISTER, MORRIS; KEIRSTEAD, RALPH E.; and SHOEMAKER, LOIS M. *The wonderworld of science* (Book IX). New York: Charles Scribner's Sons, 1946. Pp. vi + 698. (Illustrated.) $2.20.

NIELSEN, J. M. *Agnosia, apraxia, aphasia: their value in cerebral localization.* New York: Paul B. Hoeber, 1946. Pp. x + 292. (Illustrated.) $5.00.

POWERS, WENDELL H. (Ed.) *Advancing fronts of chemistry.* Vol. II: *Chemotherapy.* New York: Reinhold, 1946. Pp. 156. (Illustrated.) $3.25.

RUSSELL, BERTRAND. *Physics and experience.* Cambridge, Engl.: At the Univ. Press; New York: Macmillan, 1946. Pp. 26. $.50.

SPIER, LESLIE. *Comparative vocabularies and paradigms of texts in two Yuman languages of Arizona.* Albuquerque: Univ. New Mexico Press, 1946. Pp. 1[illegible] $2.00.